

**Allocations of Total Maximum Daily Loads of
Total Suspended Solids, Nitrogen and Phosphorus for
Kawa Stream
Kaneohe, Hawaii**

Report to the U.S. Environmental Protection Agency

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Executive Summary

Total maximum daily loads (TMDLs) for total suspended solids, nitrogen, and phosphorus in Kawa Stream in Kaneohe, Hawaii, were approved by the U.S. Environmental Protection Agency (EPA) in 2002. A condition of EPA's approval was that Hawaii allocate the approved TMDLs between point source discharges regulated under Clean Water Act discharge permit and nonpoint source runoff that is not regulated by discharge permit. This report provides those allocations: wasteload allocations (WLAs) for the permitted municipal separate storm sewer systems (MS4) of the City & County of Honolulu and the State of Hawaii Department of Transportation; WLAs for the permitted small MS4 facilities of the City & County of Honolulu Department of Parks and Recreation, the State of Hawaii Department of Education (schools), and the State of Hawaii Department of Defense Veterans Cemetery; and load allocations (LAs) for the nonpoint source runoff areas of the Kawa watershed.

TMDLs for Kawa Stream were developed in 2002 for total suspended solids (TSS), total nitrogen (TN), and total phosphorus (TP) for three conditions: dry season (May – October) baseflow, wet season (November – April) baseflow, and storm runoff. For each parameter and streamflow condition, the TMDL was calculated as the Kawa Stream load capacity (LC) less a margin of safety (MOS) equivalent to 10 percent of the existing non-background pollutant loading. Streamflow conditions, criteria, and TMDLs are unchanged in this report from those approved by EPA in 2002. Some adjustments are made to land use distributions and the calculation methods for streamflow and pollutant loadings to provide a more transparent pollutant distribution and TMDL allocation process.

Nonpoint source areas outside the jurisdiction of MS4 permits are the Hawaiian Memorial Park Cemetery, Bay View Golf Park, and forested areas of the Kawa watershed. Baseflow volumes (91% dry season, 79% wet season) and baseflow nitrogen loads (82% dry season, 72% wet season) originate largely from these nonpoint source areas - primarily forest. Storm sewer discharges are regulated under MS4 permits and originate in the storm runoff from park, school, residential, commercial, street, and highway areas of the watershed. Most of the storm runoff volume (86%) and pollutant load (95% of TSS, 92% of TN, 91% of TP) is from these MS4 areas.

Contributing sources and allocations of the Kawa Stream TMDLs for TSS, TN, and TP are summarized in the following Kawa Stream TMDL Allocations table (Table 10.1, p. 11 of this report):

Kawa Stream TMDL Allocations (Table 10.1, p. 11)

CCH Environmental Services	= Park + Residential + Commercial + CCH Streets					
CCH Parks & Recreation	= Kaneohe Community and Senior Center (Park)					
DOT Highways	= Highways, DOT					
DOE schools	= Schools (Public)					
DOD cemetery	= Veterans Cemetery					
Nonpoint sources	= Forest + Cemetery (private) + Golf					
DRY SEASON BASE FLOW	TMDL (kg)			TMDL (kg/day)		
	TSS	TN	TP	TSS	TN	TP
LA to CCH Environmental Services Large MS4	230	4	1	1.25	0.02	0.00
LA to CCH Parks & Recreation Small MS4	2	0	0	0.01	0.00	0.00
LA to DOT Highways Large MS4	4	0	0	0.02	0.00	0.00
LA to DOE Small MS4	14	0	0	0.07	0.00	0.00
LA to DOD Small MS4	124	5	1	0.67	0.03	0.00
LA to other nonpoint sources	2,427	43	7	13.19	0.23	0.04
Totals	2,800	52	8	15.22	0.28	0.05
WET SEASON BASE FLOW	TMDL (kg)			TMDL (kg/day)		
	TSS	TN	TP	TSS	TN	TP
LA to CCH Environmental Services Large MS4	1,477	17	4	8.16	0.09	0.02
LA to CCH Parks & Recreation Small MS4	7	0	0	0.04	0.00	0.00
LA to DOT Highways Large MS4	24	0	0	0.13	0.00	0.00
LA to DOE Small MS4	113	3	1	0.63	0.01	0.00
LA to DOD Small MS4	369	10	1	2.04	0.06	0.01
LA to other nonpoint sources	6,210	77	15	34.31	0.43	0.08
Totals	8,201	108	21	45.31	0.60	0.12
ANNUAL STORM RUNOFF	TMDL (kg)			TMDL (kg/day)		
	TSS	TN	TP	TSS	TN	TP
WLA to CCH Environmental Services Large MS4	11,995	178	62	32.86	0.49	0.17
WLA to CCH Parks & Recreation Small MS4	15	0	0	0.04	0.00	0.00
WLA to DOT Highways Large MS4	2,035	17	4	5.57	0.05	0.01
WLA to DOE Small MS4	971	16	6	2.66	0.04	0.02
WLA to DOD Small MS4	172	4	2	0.47	0.01	0.01
LA to nonpoint sources	790	20	7	2.17	0.05	0.02
Totals	15,978	234	82	43.77	0.64	0.22

Note: TMDL allocations in kg/day are obtained by dividing dry season kg by 184 days, wet season kg by 181 days and annual storm runoff kg by 365 days.

The load reductions required for each source to achieve these Kawa Stream TMDL allocations are summarized below. Implementation of the required load reductions will result in attainment of the water quality standards for TSS, TN, and TP in Kawa Stream.

Load Reductions Required to Achieve Kawa Stream TMDLs (Table 11.1, p. 12)

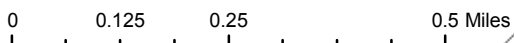
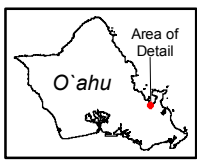
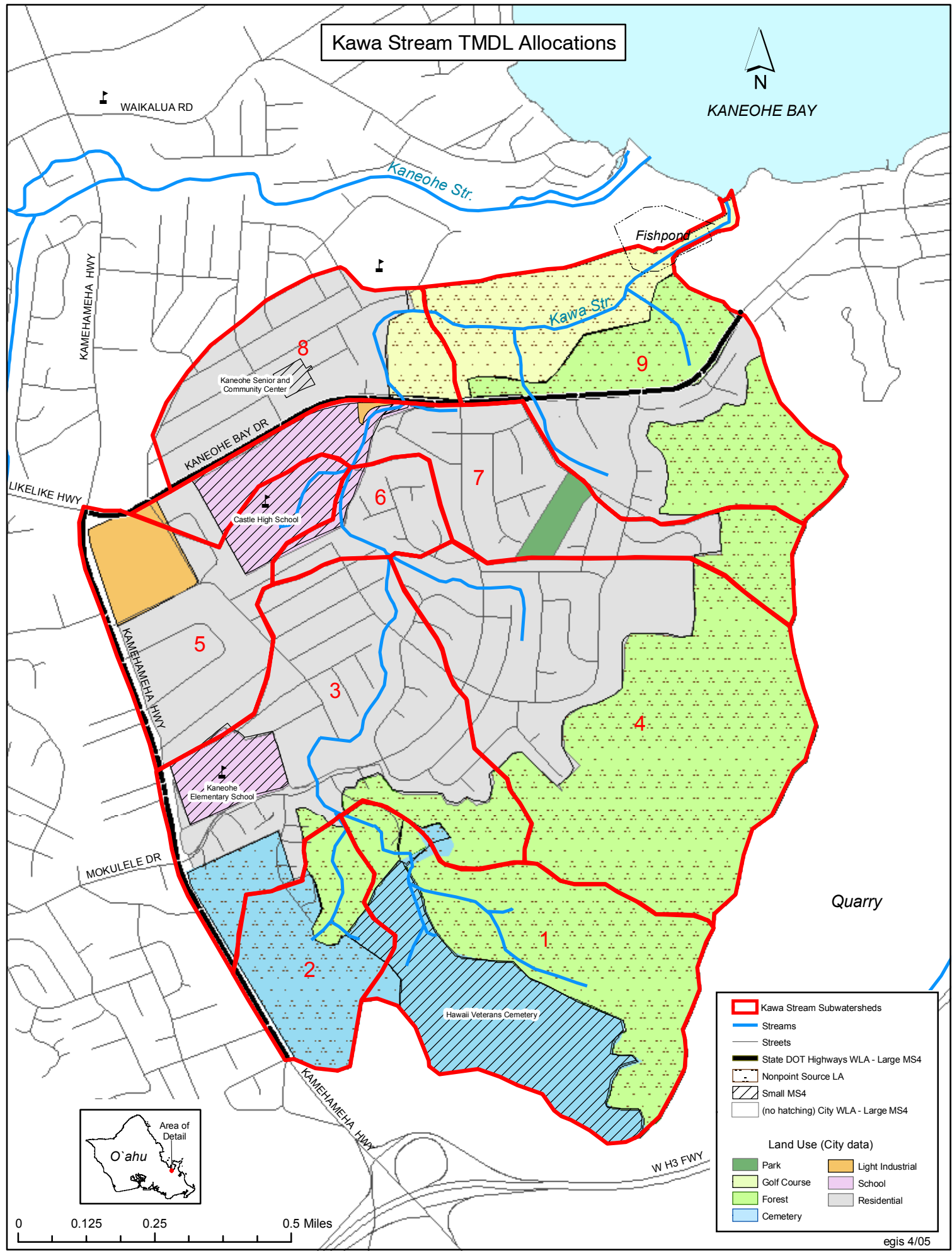
DRY SEASON BASE FLOW				EXISTING LOADS (kg)*			REDUCTIONS REQUIRED (kg & %)*					
				TSS	TN	TP	TSS		TN		TP	
							kg	%	kg	%	kg	%
LA to CCH Environmental Services Large MS4				104	21	1	0	0	18	86	0	0
LA to CCH Parks & Recreation Small MS4				1	0	0	0	0	0	0	0	0
LA to DOT Highways Large MS4				2	0	0	0	0	0	0	0	0
LA to DOE Small MS4				6	2	0	0	0	2	100	0	0
LA to DOD Small MS4				56	28	1	0	0	23	82	0	0
LA to other nonpoint sources				1,096	237	9	0	0	194	82	2	22
Totals				1,264	289	11	0	0	237	99	3	27
WET SEASON BASE FLOW				EXISTING LOADS (kg)*			REDUCTIONS REQUIRED (kg & %)*					
				TSS	TN	TP	TSS		TN		TP	
							kg	%	kg	%	kg	%
LA to CCH Environmental Services Large MS4				333	68	3	0	0	51	75	0	0
LA to CCH Parks & Recreation Small MS4				2	1	0	0	0	1	100	0	0
LA to DOT Highways Large MS4				5	1	0	0	0	1	100	0	0
LA to DOE Small MS4				26	10	0	0	0	8	80	0	0
LA to DOD Small MS4				83	42	1	0	0	31	74	0	0
LA to other nonpoint sources				1,400	308	12	0	0	231	75	0	0
Totals				1,849	430	17	0	0	322	75	0	0
ANNUAL STORM RUNOFF				EXISTING LOADS (kg)*			REDUCTIONS REQUIRED (kg & %)*					
				TSS	TN	TP	TSS		TN		TP	
							kg	%	kg	%	kg	%
WLA to CCH Environmental Services Large MS4				19,515	535	130	7,520	39	358	67	69	53
WLA to CCH Parks & Recreation Small MS4				24	1	0	9	38	1	100	0	0
WLA to DOT Highways Large MS4				3,310	53	9	1,276	39	35	66	5	56
WLA to DOE Small MS4				1,579	47	13	609	39	32	68	7	54
WLA to DOD Small MS4				279	11	4	108	39	7	64	2	50
LA to nonpoint sources				1,286	59	15	496	39	39	66	8	53
Totals				25,994	707	172	10,017	39	472	67	90	52

*Existing Loads and Load Reductions rounded to the nearest kg, thus (a) **Totals** may be different than the sum of their parts and (b) **EXISTING LOADS** and **REDUCTIONS REQUIRED** may actually be greater than 0, and (c) **REDUCTIONS REQUIRED** may actually be less than 100% for existing loads of 1-2 kg.

Wasteload allocations (WLAs) for the Kawa Stream TMDLs will be implemented through compliance with NPDES MS4 permit conditions (Phase I large facilities and Phase II small facilities) and by following the stormwater management plans associated with those

permits. Load allocations (LAs) may be implemented through a variety of voluntary approaches polluted runoff control, including those described in the existing TMDL Implementation Plan developed by the DOH (Environmental Planning Office 2002). DOH recently funded a watershed-based planning project in the Koolaupoko watershed, addressing the nine elements required by EPA guidance that unlock the door to additional Clean Water Act §319(h) incremental funds (EPA 2003). This Watershed Based Plan is expected to augment and supersede the existing TMDL Implementation Plan by incorporating the LA objectives from Table 10.1 above.

Kawa Stream TMDL Allocations



Kawa Stream Subwatersheds

— Streams

— Streets

State DOT Highways WLA - Large MS4

Nonpoint Source LA

Small MS4

(no hatching) City WLA - Large MS4

Land Use (City data)

Park

Light Industrial

Golf Course

Cemetery

Forest

School

Residential

egis 4/05

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Allocations of Total Maximum Daily Loads of Total Suspended Solids, Nitrogen and Phosphorus for Kawa Stream, Kaneohe, Hawaii

Report to the U.S. Environmental Protection Agency – June 21, 2005

1.0 Introduction

Total maximum daily loads (TMDLs) developed by the State of Hawaii Department of Health (DOH) for total suspended solids, total nitrogen, and total phosphorus were approved by the U.S. Environmental Protection Agency (EPA) on June 19, 2002. The EPA approval was conditioned on DOH's subsequent apportioning of the approved TMDLs between those sources regulated under State National Pollutant Discharge Elimination System (NPDES) permits and the nonpoint source runoff not regulated by NPDES permits. This report provides these requested allocations. The report was prepared by Jack D. Smith (DOH contractor) and David C. Penn and Glen Fukunaga (DOH Environmental Planning Office), with assistance from Robert Bourke (Oceanit Laboratories, Inc.) and Tom Nance (Water Resource Engineering). This work was funded by the EPA through the FY-05 Water Pollution Control program grant to DOH (Clean Water Act §106) and by State budgeting for staff positions and office support within DOH.

2.0 Method and Assumptions

No new data were collected for this report. The land use distribution presented in the EPA-approved TMDL report (Oceanit Laboratories, Inc. 2002 – hereafter "the 2002 TMDL Report") is adjusted to include a section of State highway along the boundary of the watershed and to facilitate the TMDL allocations and their subsequent implementation. Conventional storm runoff and baseflow recession formulations are employed to provide a more transparent pollutant load distribution and allocation process. Stormwater concentration data are updated with information reported by the National Urban Runoff Program (EPA 1983), National Water-Quality Assessment (USGS 2004), and the City & County of Honolulu (CCH 1991 & 1992). Internal pollutant load distributions are adjusted accordingly. The net pollutant load and streamflow conditions that were the basis for the approved TMDLs remain the basis in this report for the allocations of those TMDLs.

3.0 Land Use Adjustments

The land use distribution in the 2002 TMDL report (Table 2.1) included areas of street surface in each subbasin, but no distinctions between CCH streets and State of Hawaii Department of Transportation (DOT) highways. For this report, street areas in the 2002 TMDL report are apportioned between CCH and DOT. State highway areas are calculated assuming a general 60-foot ROW (Right Of Way) width, 1.25-mile length for Kaneohe Bay Drive, and 1.10-mile length for Kamehameha Highway. The calculated area of Kaneohe Bay Drive is subtracted from 2002 TMDL report street area and separately accounted for in this report. The area of Kamehameha Highway along the northerly boundary of the Kawa Stream watershed was not included in the watershed area in the 2002 TMDL report. This small area (7.65 acres) is added

to the watershed in this report because this portion of the highway effectively drains to Kawa Stream.

In addition, a distinction is made in this report between streets or highways with curbs (and gutters) and those without curbs. Stormwater runoff from the former will flow directly into storm sewers and to surface water discharge. Runoff from the latter will flow through roadside swales for some distance before entry to a downstream storm sewer. In this latter instance, some of the runoff will infiltrate and some of the pollutant load will be retained by the grassed swale, so both stormwater volumes and pollutant loads from these areas will be reduced. The drainage distinction in this report allows the different pollutant load potentials to be recognized and accounted for in the TMDL allocations. The adjusted land use distribution used for this report is presented here in Table 3.1 in terms of absolute acres rather than the relative percentages in the 2002 TMDL report.

Table 3.1. Kawa Watershed Land Use Distribution

LAND USE AREAS (Acres)							Streets, CCH		Highways, DOT			Totals
Basin	Forest	Cemetery	Park	Golf	School	Res. Comm.	w/curbs	w/o curbs	w/curbs	w/o curbs		
1	84.44	65.79	0	0	0	0	0	0.22	0	0		150.45
2	11.85	38.46	0	0	0	0.16	0	0.44	0	1.60		52.51
3	20.17	12.86	0	0	18.53	81.72	0	4.65	4.65	2.88	0	145.46
4	135.25	0	0	0	0	78.51	0	5.91	0	0	0	219.67
5	0	0	0	0	16.42	42.87	17.79	0	3.16	2.20	1.00	83.44
6	0	0	0	0	2.86	21.67	0	1.57	0	0	0	26.10
7	16.25	0	6.48	1.01	20.90	56.33	1.42	2.09	0.92	0	3.20	108.60
8	0	0	2.00	11.59	0	47.47	0	0	2.07	2.11	0.59	65.83
9	73.63	0	0	45.35	0	25.60	0	1.04	0	0	2.02	147.64
Totals	341.59	117.11	8.48	57.95	58.71	354.33	19.21	15.70	11.02	7.19	8.41	999.70

Effective impervious area fractions are estimated for each of the Table 3.1 land use area areas based on field observation of representative parcels and calibration with previously estimated stormflow volumes from the 2002 TMDL report. Effective impervious area is that portion of the impervious area that drains directly to the primary stormwater collection system, i.e., to the street gutters or storm sewers and not to sumps, lawns, or other pervious areas. The effective impervious fraction estimates used in this report are presented in Table 3.2.

Table 3.2. Kawa Watershed Effective Impervious Areas

IMPERVIOUS AREA FRACTIONS							Streets, CCH		Highways, DOT		
Basin	Forest	Cemetery	Park	Golf	School	Res. Comm.	w/curbs	w/o curbs	w/curbs	w/o curbs	
1	0	0.01							0.8		
2	0	0.02				0.40		1			0.75
3	0	0.03			0.2	0.30		1	0.8	0.85	
4	0					0.30		1			
5					0.2	0.40	0.8		0.8	0.85	0.75
6					0.2	0.40		1			
7	0		0.10	0.03	0.3	0.25	0.9	1	0.8		0.55
8	0		0.25	0.02		0.25			0.8	1.00	0.75
9	0			0.01		0.25		1			0.45

An attempt is made in this report to approximate distributions of rainfall and evaporation in the Kawa Stream watershed area, in order to better represent the distributions of runoff and baseflow sources in the watershed. The Technical Appendix to this report describes the statistical correlations of rainfall with site elevation and evaporation with rainfall that are the basis of runoff and streamflow distributions developed in this report. Elevation is the principal factor directly relating rainfall between different locations and indirectly also relating evaporation quantities. The elevations used in this report for calculating rainfall and evaporation distributions (Table 3.3) are based on visual interpolation of contours shown on standard U.S. Geological Survey topographic quadrangle maps.

Table 3.3. Kawa Watershed Elevations

LAND USE ELEVATIONS (feet-MSL)						Streets, CCH		Highways, DOT	
Basin	Forest	Cemetery	Park	Golf	School	Res. Comm.	w/curbs	w/o curbs	w/o curbs
1	500	300						200	
2	150	200				150	150		200
3	150	150			150	125	125	125	150
4	600					150	150		
5					75	75	75	75	80
6					75	75	75		
7	400		175	75	75	100	75	100	75
8			75	20		75		75	75
9	400			20		150	150		150

4.0 Flow Distributions

Annual stormwater runoff volume contributions are calculated for each of the Table 3.1 land use area parcels using the runoff formulation proposed by CCH and described in the Technical Appendix. Dry season and wet season mean baseflow volume contributions are calculated for each land use area parcel using the baseflow recession model described in the Technical Appendix. These distributions are presented in Tables 4.1, 4.2, and 4.3 for dry season baseflow, wet season baseflow, and annual storm runoff, respectively. The total volumes from each table are closely the same as the respective water balance volumes for year 2000 in Table 4.10 of the 2002 TMDL report (storm runoff is slightly greater here because of the added highway area). The calculations here provide a source distribution for that 2002 water balance.

Table 4.1. Kawa Watershed Dry Season Baseflow Sources

DRY SEASON BASEFLOW SOURCES (million cubic feet)							Streets, CCH		Highways, DOT			Totals
Basin	Forest	Cemetery	Park	Golf	School	Res.	Comm.	w/curbs	w/o curbs	w/curbs	w/o curbs	
1	2.38	0.96	0	0	0	0	0	0	0.00	0	0	3.35
2	0.06	0.30	0	0	0	0.00	0	0	0	0	0.00	0.36
3	0.09	0.06	0	0	0.07	0.17	0	0	0.00	0.00	0	0.40
4	4.73	0	0	0	0	0.26	0	0	0	0	0	4.99
5	0	0	0	0	0.00	-0.01	0.00	0	0.00	0.00	0.00	-0.02
6	0	0	0	0	0.00	0.00	0	0	0	0	0	-0.01
7	0.35	0	0.04	0.00	-0.01	0.06	0.00	0	0.00	0	0.00	0.44
8	0	0	0	-0.05	0	-0.01	0	0	0.00	0	0.00	-0.06
9	1.58	0	0	-0.18	0	0.09	0	0	0	0	0.01	1.50
Totals	9.20	1.32	0.04	-0.23	0.06	0.55	0.00	0	0.00	0.00	0.01	10.95

Table 4.2. Kawa Watershed Wet Season Baseflow Sources

WET SEASON BASEFLOW SOURCES (million cubic feet)							Streets, CCH		Highways, DOT			Totals
Basin	Forest	Cemetery	Park	Golf	School	Res.	Comm.	w/curbs	w/o curbs	w/curbs	w/o curbs	
1	2.97	1.36	0	0	0	0	0	0	0.00	0	0	4.34
2	0.12	0.52	0	0	0	0.00	0	0	0	0	0.01	0.65
3	0.21	0.13	0	0	0.15	0.48	0	0	0.01	0.00	0	0.98
4	5.73	0	0	0	0	0.56	0	0	0	0	0	6.29
5	0	0	0	0	0.06	0.12	0.02	0	0.00	0.00	0.00	0.21
6	0	0	0	0	0.01	0.06	0	0	0	0	0	0.07
7	0.46	0	0.07	0.00	0.07	0.28	0.00	0	0.00	0	0.01	0.89
8	0	0	0.01	0.01	0	0.17	0	0	0.00	0	0.00	0.19
9	2.07	0	0	0.04	0	0.20	0	0	0	0	0.01	2.32
Totals	11.56	2.01	0.08	0.06	0.30	1.88	0.02	0	0.01	0.01	0.03	15.94

Table 4.3. Kawa Watershed Storm Runoff Sources

ANNUAL STORM RUNOFF SOURCES (million cubic feet)							Streets, CCH		Highways, DOT			Totals
Basin	Forest	Cemetery	Park	Golf	School	Res.	Comm.	w/curbs	w/o curbs	w/curbs	w/o curbs	
1	0.67	0.55	0	0	0	0	0	0	0.02	0	0	1.24
2	0.07	0.34	0	0	0	0.01	0	0.05	0	0	0.15	0.63
3	0.13	0.12	0	0	0.54	3.23	0	0.55	0.44	0.30	0	5.31
4	1.15	0	0	0	0	3.17	0	0.71	0	0	0	5.02
5	0	0	0	0	0.45	2.09	1.63	0	0.29	0.21	0.09	4.75
6	0	0	0	0	0.08	1.06	0	0.18	0	0	0	1.31
7	0.12	0	0.12	0.01	0.79	1.88	0.15	0.24	0.09	0	0.21	3.60
8	0	0	0.07	0.09	0	1.55	0	0	0.19	0.24	0.05	2.18
9	0.55	0	0	0.30	0	0.89	0	0.12	0	0	0.12	1.98
Totals	2.70	1.01	0.18	0.40	1.86	13.87	1.77	1.85	1.03	0.75	0.61	26.03

5.0 Pollutant Concentrations

Pollutant concentrations that are associated in this report with land use sources are presented in Table 5.1. Baseflow concentrations in this table are developed from baseline stream quality data in the 2002 TMDL report (Tables 4.1, 4.4) and reported mean USGS NAWQA shallow-well groundwater concentrations from forest, agriculture and urban areas, also in the 2002 TMDL report (Table 5.2). Storm runoff concentrations are developed from runoff-influenced concentration data in the 2002 TMDL report (Tables 4.3, 4.7) and from event mean concentration (EMC) data reported for commercial, industrial, residential, and highway land use categories by EPA's National Urban Runoff Program (EPA 1983, Pitt et al. 2003). Street runoff concentrations are estimated from CCH NPDES permit monitoring data. Concentrations are reduced by 20-30 percent for the streets and highways without curbs, assuming this level of pollutant removal by vegetated swale areas before runoff enters the storm sewer system. Based on highway survey data elsewhere, this appears to be a conservative assumption (Cammermayer et al 2000).

Table 5.1. Kawa Watershed Pollutant Source Concentrations

Baseflow Concentrations (mg/l)						Streets, CCH		Highways, DOT			
Constituent	Forest	Cemetery	Park	Golf	School	Res.	Comm.	w/curbs	w/o curbs	w/curbs	w/o curbs
Suspended solids	4	3	3	3	3	6	6	6	6	6	6
Nitrogen, total	0.8	1.5	1.5	1.5	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Phosphorus, total	0.032	0.042	0.04	0.042	0.054	0.06	0.06	0.06	0.06	0.06	0.06
Runoff Concentrations (mg/l)						Streets		Highways			
Constituent	Forest	Cemetery	Park	Golf	School	Res.	Comm.	w/curbs	w/o curbs	w/curbs	w/o curbs
Suspended solids	10	20	20	20	30	30	40	80	50	99	70
Nitrogen, total	0.5	0.8	0.8	0.8	0.9	0.9	1.3	1.5	1.2	1.5	1.2
Phosphorus, total	0.1	0.3	0.25	0.3	0.25	0.25	0.2	0.25	0.2	0.25	0.2

6.0 Pollutant Load Distributions

Estimated pollutant load contributions from each land use source are obtained by multiplying the baseflow or runoff concentration for that source category, from Table 5.1, by the respective baseflow or runoff volume from Table 4.1, 4.2, or 4.3 and correcting for unit dimensions. The distributions of existing (year 2000 conditions) total suspended solids (TSS), total nitrogen (TN), and total phosphorus (TP) loads are presented in the following Tables 6.1 through 6.3.

Table 6.1. Existing Kawa Watershed TSS Load Distributions

a. Dry Season TSS Load (kg)												
Basin	Forest	Cemetery	Park	Golf	School	Res.	Comm.	Streets, CCH		Highways, DOT		Totals
								w/curbs	w/o curbs	w/curbs	w/o curbs	
1	274	83	0	0	0	0	0	0	0	0	0	357
2	7	26	0	0	0	0	0	0	0	0	1	34
3	11	5	0	0	6	31	0	0	0	0	0	54
4	542	0	0	0	0	45	0	0	0	0	0	588
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0
7	40	0	3	0	0	10	0	0	0	0	0	53
8	0	0	0	0	0	0	0	0	0	0	0	0
9	163	0	0	0	0	14	0	0	0	0	1	178
	0											
Totals	1,037	115	3	0	6	101	0	0	1	0	1	1,264
b. Wet Season TSS Load (kg)												
Basin	Forest	Cemetery	Park	Golf	School	Res.	Comm.	Streets, CCH		Highways, DOT		Totals
								w/curbs	w/o curbs	w/curbs	w/o curbs	
1	336	116	0	0	0	0	0	0	0	0	0	452
2	14	44	0	0	0	0	0	0	0	0	1	59
3	23	11	0	0	13	82	0	0	1	1	0	132
4	648	0	0	0	0	96	0	0	0	0	0	744
5	0	0	0	0	6	22	3	0	1	0	0	31
6	0	0	0	0	1	11	0	0	0	0	0	12
7	52	0	6	0	6	48	0	0	0	0	1	114
8	0	0	1	1	0	30	0	0	0	0	0	32
9	234	0	0	4	0	33	0	0	0	0	2	273
Totals	1,307	171	7	5	26	322	3	0	3	1	4	1,849
c. Annual Storm Runoff TSS Load (kg)												
Basin	Forest	Cemetery	Park	Golf	School	Res.	Comm.	Streets, CCH		Highways, DOT		Totals
								w/curbs	w/o curbs	w/curbs	w/o curbs	
1	191	309	0	0	0	0	0	0	31	0	0	531
2	21	194	0	0	0	7	0	119	0	0	301	642
3	36	71	0	0	456	2,747	0	1,237	627	829	0	6,004
4	324	0	0	0	0	2,690	0	1,603	0	0	0	4,618
5	0	0	0	0	381	1,774	1,844	0	409	600	171	5,180
6	0	0	0	0	66	897	0	401	0	0	0	1,365
7	35	0	66	5	675	1,595	164	545	122	0	411	3,618
8	0	0	37	51	0	1,318	0	0	268	668	101	2,442
9	157	0	0	172	0	754	0	282	0	0	230	1,594
Totals	764	573	103	228	1,579	11,782	2,008	4,189	1,457	2,097	1,214	25,994

Table 6.2. Existing Kawa Watershed TN Load Distributions

a. Dry Season TN Load (kg)												
Basin	Forest	Cemetery	Park	Golf	School	Res.	Comm.	Streets, CCH		Highways, DOT		Totals
								w/curbs	w/o curbs	w/curbs	w/o curbs	
1	55	42	0	0	0	0	0	0	0	0	0	96
2	1	13	0	0	0	0	0	0	0	0	0	15
3	2	3	0	0	2	6	0	0	0	0	0	14
4	108	0	0	0	0	9	0	0	0	0	0	118
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0
7	8	0	2	0	0	2	0	0	0	0	0	12
8	0	0	0	0	0	0	0	0	0	0	0	0
9	33	0	0	0	0	3	0	0	0	0	0	36
	0											
Totals	207	57	2	0	2	20	0	0	0	0	0	289
b. Wet Season TN Load (kg)												
Basin	Forest	Cemetery	Park	Golf	School	Res.	Comm.	Streets, CCH		Highways, DOT		Totals
								w/curbs	w/o curbs	w/curbs	w/o curbs	
1	67	58	0	0	0	0	0	0	0	0	0	125
2	3	22	0	0	0	0	0	0	0	0	0	25
3	5	5	0	0	5	16	0	0	0	0	0	32
4	130	0	0	0	0	19	0	0	0	0	0	149
5	0	0	0	0	2	4	1	0	0	0	0	7
6	0	0	0	0	0	2	0	0	0	0	0	3
7	10	0	3	0	2	10	0	0	0	0	0	26
8	0	0	0	0	0	6	0	0	0	0	0	7
9	47	0	0	2	0	7	0	0	0	0	0	56
Totals	261	85	3	3	10	64	1	0	1	0	1	430
c. Annual Storm Runoff TN Load (kg)												
Basin	Forest	Cemetery	Park	Golf	School	Res.	Comm.	Streets, CCH		Highways, DOT		Totals
								w/curbs	w/o curbs	w/curbs	w/o curbs	
1	10	12	0	0	0	0	0	0	1	0	0	23
2	1	8	0	0	0	0	0	2	0	0	5	16
3	2	3	0	0	14	82	0	23	15	13	0	152
4	16	0	0	0	0	81	0	30	0	0	0	127
5	0	0	0	0	11	53	60	0	10	9	3	146
6	0	0	0	0	2	27	0	8	0	0	0	36
7	2	0	3	0	20	48	5	10	3	0	7	98
8	0	0	1	2	0	40	0	0	6	10	2	61
9	8	0	0	7	0	23	0	5	0	0	4	47
Totals	38	23	4	9	47	353	65	79	35	32	21	707

Table 6.3. Existing Kawa Watershed TP Load Distribution

a. Dry Season TP Load (kg)												
Basin	Forest	Cemetery	Park	Golf	School	Res.	Comm.	Streets, CCH		Highways, DOT		Totals
								w/curbs	w/o curbs	w/curbs	w/o curbs	
1	2	1	0	0	0	0	0	0	0	0	0	3
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	1
4	4	0	0	0	0	0	0	0	0	0	0	5
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0
9	1	0	0	0	0	0	0	0	0	0	0	1
	0											
Totals	8	2	0	0	0	1	0	0	0	0	0	11
b. Wet Season TP Load (kg)												
Basin	Forest	Cemetery	Park	Golf	School	Res.	Comm.	Streets, CCH		Highways, DOT		Totals
								w/curbs	w/o curbs	w/curbs	w/o curbs	
1	3	2	0	0	0	0	0	0	0	0	0	4
2	0	1	0	0	0	0	0	0	0	0	0	1
3	0	0	0	0	0	1	0	0	0	0	0	1
4	5	0	0	0	0	1	0	0	0	0	0	6
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	1
8	0	0	0	0	0	0	0	0	0	0	0	0
9	2	0	0	0	0	0	0	0	0	0	0	2
Totals	10	2	0	0	0	3	0	0	0	0	0	17
c. Annual Storm Runoff TP Load (kg)												
Basin	Forest	Cemetery	Park	Golf	School	Res.	Comm.	Streets, CCH		Highways, DOT		Totals
								w/curbs	w/o curbs	w/curbs	w/o curbs	
1	2	5	0	0	0	0	0	0	0	0	0	7
2	0	3	0	0	0	0	0	0	0	0	1	4
3	0	1	0	0	4	23	0	4	3	2	0	37
4	3	0	0	0	0	22	0	5	0	0	0	31
5	0	0	0	0	3	15	9	0	2	2	0	31
6	0	0	0	0	1	7	0	1	0	0	0	9
7	0	0	1	0	6	13	1	2	0	0	1	24
8	0	0	0	1	0	11	0	0	1	2	0	15
9	2	0	0	3	0	6	0	1	0	0	1	12
Totals	8	9	1	3	13	98	10	13	6	5	3	170

7.0 Source Descriptions

Load source categories are consolidated here into loads from areas serviced by agencies that hold or should hold NPDES permits for municipal stormwater discharges (MS4 permits) and those areas that remain sources of nonpoint runoff. Residential, commercial, and CCH street areas are consolidated into the area serviced by the CCH MS4 permit. Highway areas of Kaneohe Bay Drive and Kamehameha Highway are consolidated into the area serviced by the DOT Highways Division MS4 permit (DOT 1991). Public school areas are consolidated into the area serviced by the small-facilities MS4 permit recently issued to the State of Hawaii Department of Education (DOE). The Kaneohe Community and Senior Center will be among the park facilities included under a small-facilities MS4 permit application by CCH Department of Parks & Recreation so it is accounted for separately. The Veterans Cemetery appears to require a small-facilities MS4 permit to the State of Hawaii Department of Defense (DOD) so the 57-acre area of this cemetery within the Kawa Stream watershed is also accounted for separately. Remaining as nonpoint sources of runoff are forest and Hawaiian Memorial Park cemetery areas and portions of Bay View Golf Park. This consolidation is displayed below in Table 7.1.

Table 7.1. Consolidation of Existing Loads to Major Sources

	Volume (million cubic feet)	TSS (kg)	TN (kg)	TP (kg)
Dry Season Baseflow				
CCH Environmental Services	0.58	104	21	1
CCH Parks & Recreation	0.01	1	0	0
DOT Highways	0.01	2	0	0
DOE schools	0.06	6	2	0
DOD cemetery	0.64	56	28	1
Nonpoint sources	9.65	1,096	237	9
Totals	10.95	1,264	289	11
Wet Season Baseflow				
CCH Environmental Services	1.97	333	68	3
CCH Parks & Recreation	0.02	2	1	0
DOT Highways	0.03	5	1	0
DOE schools	0.30	26	10	0
DOD cemetery	0.98	83	42	1
Nonpoint sources	12.64	1,400	308	12
Totals	15.94	1,849	430	17
Annual Storm Runoff				
CCH Environmental Services	18.66	19,515	535	128
CCH Parks & Recreation	0.04	24	1	0
DOT Highways	1.36	3,310	53	9
DOE schools	1.86	1,579	47	13
DOD cemetery	0.49	279	11	4
Nonpoint sources	3.62	1,286	59	15
Totals	26.03	25,994	707	170

Both quantity and quality of the Kawa Stream baseflow are dominated by the nonpoint source areas (primarily forest). Origins of 91% of the dry season and 79% of the wet season baseflow volumes are found in these areas. Of the baseflow nitrogen loads, 82% and 72% in the dry and wet seasons, respectively, originate in the nonpoint source areas. Conversely, most of the storm runoff volume (86%) is from areas covered by MS4 permit (72% of the total runoff volume falls under the City & County of Honolulu Large MS4 permit). Of the total storm runoff pollutant loads, 95% of TSS, 92% of TN, and 91% of TP are from the areas under the jurisdiction of large (Phase I) or small-facility (Phase II) MS4 permit.

8.0 TMDL Conditions and Criteria

TMDL criteria for dry season and wet season base flow and storm runoff flow are summarized in Table 8.1 below. These are the same criteria for the TMDLs in the 2002 TMDL report (Table 4.12).

Table 8.1. TMDL Conditions and criteria

	TSS	TN	TP
	(mg/l)	(mg/l)	(mg/l)
Dry Season Baseflow	10	0.180	0.030
Wet Season Baseflow	20	0.250	0.050
Storm Runoff Flow	25	0.350	0.125

9.0 Load Capacities and Margins of Safety

Load capacities (LC) for TSS, TN, and TP were calculated in the 2002 TMDL report for dry season and wet season base flow and storm runoff conditions based on the TMDL criteria in Table 8.1 above. Explicit margins of safety (MOS) were estimated as 10 percent of the non-background portions of the calculated load capacities. The base load quantities that were then allocated were the load capacities less the respective margins of safety. Those same quantities, i.e., LC-MOS, remain in this report as the allocation basis and are summarized in Table 9.1.

Table 9.1. Kawa Stream Allocation Bases: Loading Capacity minus Margin of Safety (LC-MOS)

	TSS	TN	TP	TSS	TN	TP
	(kg)	(kg)	(kg)	(kg/day)	(kg/day)	(kg/day)
Dry Season Baseflow	2,800	52	8	15.22	0.28	0.05
Wet Season Baseflow	8,201	108	21	45.31	0.60	0.12
Annual Storm Runoff	15,978	234	82	43.77	0.64	0.22

10.0 TMDL Allocations

The base LC-MOS load quantities in Table 9.1 are allocated in this report in proportion to the existing major source loads that are summarized in Table 7.1. The resulting load allocation

(LA) and wasteload allocation (WLA) distributions are presented in Table 10.1. The totals of these allocations, for each parameter under each condition, are the same as those in the 2002 TMDL report, Section 6.1. Based on the source descriptions presented above (Section 7.0), all watershed areas are considered as nonpoint sources of baseflow loads (LAs only), but WLAs are given to MS4 permit service areas under storm runoff conditions

Table 10.1. Kawa Stream TMDL Allocations

CCH Environmental Services	= Park + Residential + Commercial + CCH Streets					
CCH Parks & Recreation	= Kaneohe Community and Senior Center (Park)					
DOT Highways	= Highways, DOT					
DOE schools	= Schools (Public)					
DOD cemetery	= Veterans Cemetery					
Nonpoint sources	= Forest + Cemetery (private) + Golf					
DRY SEASON BASE FLOW	TMDL (kg)			TMDL (kg/day)		
	TSS	TN	TP	TSS	TN	TP
LA to CCH Environmental Services Large MS4	230	4	1	1.25	0.02	0.00
LA to CCH Parks & Recreation Small MS4	2	0	0	0.01	0.00	0.00
LA to DOT Highways Large MS4	4	0	0	0.02	0.00	0.00
LA to DOE Small MS4	14	0	0	0.07	0.00	0.00
LA to DOD Small MS4	124	5	1	0.67	0.03	0.00
LA to other nonpoint sources	2,427	43	7	13.19	0.23	0.04
Totals	2,800	52	8	15.22	0.28	0.05
WET SEASON BASE FLOW	TMDL (kg)			TMDL (kg/day)		
	TSS	TN	TP	TSS	TN	TP
LA to CCH Environmental Services Large MS4	1,477	17	4	8.16	0.09	0.02
LA to CCH Parks & Recreation Small MS4	7	0	0	0.04	0.00	0.00
LA to DOT Highways Large MS4	24	0	0	0.13	0.00	0.00
LA to DOE Small MS4	113	3	1	0.63	0.01	0.00
LA to DOD Small MS4	369	10	1	2.04	0.06	0.01
LA to other nonpoint sources	6,210	77	15	34.31	0.43	0.08
Totals	8,201	108	21	45.31	0.60	0.12
ANNUAL STORM RUNOFF	TMDL (kg)			TMDL (kg/day)		
	TSS	TN	TP	TSS	TN	TP
WLA to CCH Environmental Services Large MS4	11,995	178	62	32.86	0.49	0.17
WLA to CCH Parks & Recreation Small MS4	15	0	0	0.04	0.00	0.00
WLA to DOT Highways Large MS4	2,035	17	4	5.57	0.05	0.01
WLA to DOE Small MS4	971	16	6	2.66	0.04	0.02
WLA to DOD Small MS4	172	4	2	0.47	0.01	0.01
LA to nonpoint sources	790	20	7	2.17	0.05	0.02
Totals	15,978	234	82	43.77	0.64	0.22

Note for Table 10.1: TMDL allocations in kg/day are obtained by dividing dry season kg by 184 days, wet season kg by 181 days and annual storm runoff kg by 365 days.

11.0 Load Reduction Requirements

Load reduction requirements for each of the major sources are calculated by subtracting the TMDL allocation in Table 10.1 from the respective existing load in Table 7.1. These existing loads and load reduction requirements are summarized in Table 11.1. Where the load allocation (LA) or wasteload allocation (WLA) is greater than the existing load, the load reduction target in Table 11.1 is zero (0). Implementation of the required load reductions will result in attainment of the water quality standards for TSS, TN, and TP in Kawa Stream.

Table 11.1. Load Reductions Required to Achieve Kawa Stream TMDLs

DRY SEASON BASE FLOW	EXISTING LOADS (kg)*			REDUCTIONS REQUIRED (kg & %)*					
	TSS	TN	TP	TSS		TN		TP	
	kg	%		kg	%	kg	%	kg	%
LA to CCH Environmental Services Large MS4	104	21	1	0	0	18	86	0	0
LA to CCH Parks & Recreation Small MS4	1	0	0	0	0	0	0	0	0
LA to DOT Highways Large MS4	2	0	0	0	0	0	0	0	0
LA to DOE Small MS4	6	2	0	0	0	2	100	0	0
LA to DOD Small MS4	56	28	1	0	0	23	82	0	0
LA to other nonpoint sources	1,096	237	9	0	0	194	82	2	22
Totals	1,264	289	11	0	0	237	99	3	27
WET SEASON BASE FLOW	EXISTING LOADS (kg)*			REDUCTIONS REQUIRED (kg & %)*					
	TSS	TN	TP	TSS		TN		TP	
	kg	%		kg	%	kg	%	kg	%
LA to CCH Environmental Services Large MS4	333	68	3	0	0	51	75	0	0
LA to CCH Parks & Recreation Small MS4	2	1	0	0	0	1	100	0	0
LA to DOT Highways Large MS4	5	1	0	0	0	1	100	0	0
LA to DOE Small MS4	26	10	0	0	0	8	80	0	0
LA to DOD Small MS4	83	42	1	0	0	31	74	0	0
LA to other nonpoint sources	1,400	308	12	0	0	231	75	0	0
Totals	1,849	430	17	0	0	322	75	0	0
ANNUAL STORM RUNOFF	EXISTING LOADS (kg)*			REDUCTIONS REQUIRED (kg & %)*					
	TSS	TN	TP	TSS		TN		TP	
	kg	%		kg	%	kg	%	kg	%
WLA to CCH Environmental Services Large MS4	19,515	535	130	7,520	39	358	67	69	53
WLA to CCH Parks & Recreation Small MS4	24	1	0	9	38	1	100	0	0
WLA to DOT Highways Large MS4	3,310	53	9	1,276	39	35	66	5	56
WLA to DOE Small MS4	1,579	47	13	609	39	32	68	7	54
WLA to DOD Small MS4	279	11	4	108	39	7	64	2	50
LA to nonpoint sources	1,286	59	15	496	39	39	66	8	53
Totals	25,994	707	172	10,017	39	472	67	90	52

*Existing Loads and Load Reductions rounded to the nearest kg, thus (a) **Totals** may be different than the sum of their parts and (b) **EXISTING LOADS** and **REDUCTIONS REQUIRED** may actually be greater than 0, and (c) **REDUCTIONS REQUIRED** may actually be less than 100% for existing loads of 1-2 kg.

12.0 Implementation Assurance

The Large MS4 wasteload allocations (WLAs) to the State of Hawaii Department of Transportation (DOT) and to the City & County of Honolulu (CCH) will be implemented through NPDES permits for those agencies. The State of Hawaii Department of Health (DOH) is currently renewing the permits for both agencies and expects their reissue in 2005 (No. HI S000001 to DOT; No. HI S000002 to CCH). These revised permits will call for the respective permittees to develop implementation and monitoring plans for each of the WLAs in Table 10.1 above. The WLA implementation plans shall identify specific actions targeted to achieving the needed reductions of total suspended solids, total nitrogen, and total phosphorus. The monitoring plans shall specify the water quality monitoring and activity tracking necessary to demonstrate compliance with the WLAs assigned to the permittees. The NPDES permits will require that the permittees shall develop and submit to DOH these implementation and monitoring plans within one year of the adoption date of the WLA.

TMDL implementation will be assisted by the submittal of information and the development of stormwater management plans for public facilities required under NPDES Phase II (Small facility MS4 permits). All public facilities on Oahu with more than one building and an underground drainage system (as indicated by an inlet/outlet that leads to/from a subsurface conveyance structure) are required to apply for permit coverage. Wasteload allocations (WLAs) for these facilities are presented in Table 10.1 above, and their permitting status is discussed below.

There are two public schools (Kaneohe Elementary and Castle High) within the Kawa watershed that are included under the recently issued State of Hawaii Department of Education (DOE) Small MS4 permit (No. HI S000003), with a scheduled compliance date of January 28, 2006 (Clean Water Branch 2005). Puohala Elementary School (across from Bay View Golf Course near the mouth of Kaneohe Stream) is also covered under the DOE permit but is assumed to be outside of the drainage area of the freshwater stream. Its WLAs will be included in future TMDLs. One CCH Department of Parks & Recreation facility (Kaneohe Community and Senior Center) will be included in their pending Small MS4 permit application. Three additional Parks & Recreation facilities in the area (Kaluapuhi Neighborhood Park, Puohala Neighborhood Park, and the new Bayview Park) do not appear to require permit coverage, and two of these (Puohala and Bayview) are assumed to be outside of the drainage area of the freshwater stream, as is the Kaneohe Sewage Treatment Plant site (CCH Department of Environmental Services) located between the mouths of Kawa and Kaneohe streams. The Hawaii Veterans Cemetery (State of Hawaii Department of Defense) also appears to require permit coverage and recently met with DOH to learn about the application process.

The nonpoint source load allocations (LAs) for Kawa Stream may be implemented through a variety of voluntary approaches to polluted runoff control, including those described in the existing TMDL Implementation Plan (Environmental Planning Office 2002) and Koolaupoko Water Quality Action Plan (Kailua Bay Advisory Council 2002). Priority areas suggested in the TMDL Implementation Plan include nitrogen loading from cemetery, school, residential and commercial areas; phosphorous loading from forest and residential areas; and sediment loading from cemetery and residential areas and from erosion and scour of the stream channel itself.

A DOH funded project in the Kawa estuary is currently demonstrating water quality improvements through the use of floating bioremediation platforms, and the Waikalualoko Fishpond Preservation Society has teamed with the Windward Ahupua'a Alliance to accelerate habitat improvement efforts nearby. In the tributary that drains Basin 4, the City & County of Honolulu is poised to begin constructing 900 lineal feet of channel modifications that will reduce erosion and sediment loading but may negatively impact water temperatures and associated stream biochemistry.

DOH recently funded a watershed-based planning project in the Kaneohe Bay watershed in 2005, addressing the nine elements required by EPA guidance that unlock the door to additional Clean Water Act §319(h) incremental funds (EPA 2003). This Watershed Based Plan is expected to augment and supersede the existing TMDL Implementation Plan by incorporating the LA objectives from Table 10.1 above. The pollutant load distributions detailed in Tables 6.1, 6.2, and 6.3 of this report will provide a useful focus for this watershed-based planning effort.

13.0 Public Participation

During the TMDL development process, we discussed the TMDLs with various stakeholders and sources of information, including:

State of Hawaii Department of Transportation (Highways Division)
State of Hawaii Commission on Water Resource Management
Hawaii Veterans Cemetery (State of Hawaii Department of Defense)
City & County of Honolulu Department of Environmental Services
City & County of Honolulu Board of Water Supply
State of Hawaii Department of Education
State of Hawaii Department of Health (Clean Water Branch)
U.S. Environmental Protection Agency

A draft TMDL report was published on April 8, 2005. During the public review period (April 8-May 20, 2005), a public information meeting was held (May 2, 2005) to present and discuss the results of the draft report. No formal public comment was received during the public review period, and informal comments and questions presented by the City & County of Honolulu Department of Environmental Services were discussed in meeting on May 2, 2005.

14.0 References

Cammermayer, Jon W., Richard R. Horner, and Naomi Chechowitz (2000), "Vegetated Stormwater Facility Maintenance," Report No. WA-RD 495.1, Washington State Transportation Center (TRAC). <http://depts.washington.edu/trac/bulkdisk/pdf/495.1.pdf>.

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